Lessons Learned in the Integration of Earth Remote Sensing Data within the NOAA/NWS Damage Assessment Toolkit

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Background

- April 27, 2011: NASA SPoRT provides MODIS and ASTER imagery to NWS field offices in Alabama
  - Imagery was used to refine and adjust some tornado tracks, particularly those that crossed NWS coverage area boundaries or occurred in inaccessible areas
- SPoRT was awarded a NASA Applied Science: Disasters award to include Earth remote sensing within the NOAA/NWS Damage Assessment Toolkit (DAT)
  - The DAT is a smartphone, tablet, and web-based framework for collecting, revising, and publishing severe weather damage assessment information.
- Feasibility to Decisions award extended the work with a focus on the “transition to operations” of this effort.

Damage Assessment Toolkit

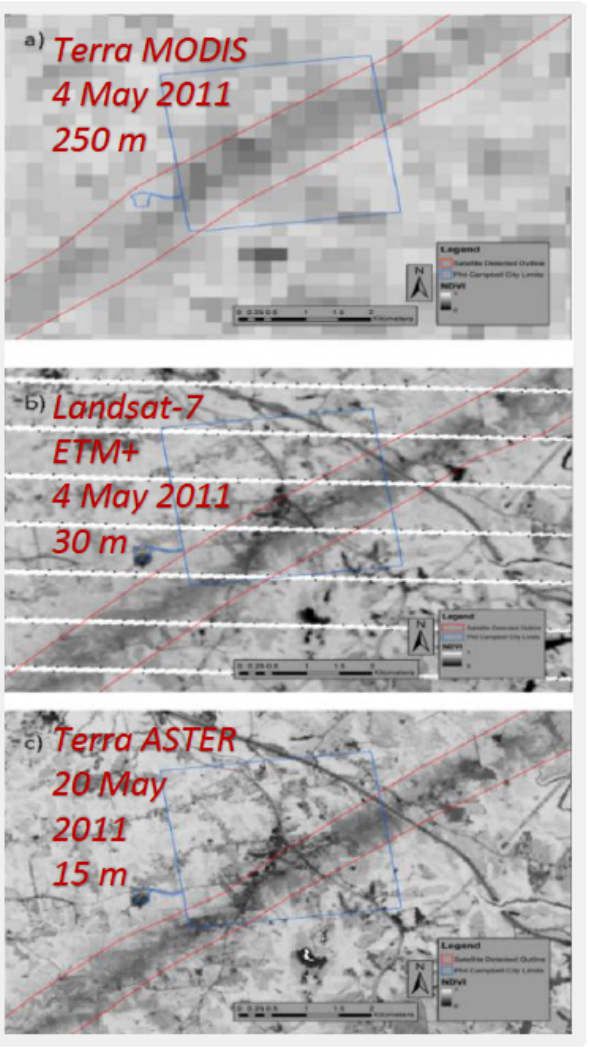
- NOAA/NWS Damage Assessment Toolkit (DAT)
  - The DAT is a smartphone, tablet, and web-based framework for acquiring, editing, and publishing storm survey information.
  - Users can acquire geotagged photos and other information, assess storm damage and intensity, and log for further review at their office. Information collected provides additional spatial data regarding tornado damage, extent, and intensity.
- Through the NASA Applied Science award, SPoRT and NOAA/NWS collaborate to establish a Web Mapping Service and data feeds that provide satellite imagery and products as viewable data layers.

Satellite Products

Platform	Sensor	Product	Resolution	Repeat Cycle	Source
Terra / Aqua	MODIS	NDVI True Color	250 m 500 m	Daily	Direct Broadcast (CIMSS) NASA LANCE
Terra	ASTER	False Color	15 m	Requested	ASTER Expedited Data
Suomi NPP	VIIRS	NDVI True Color	375 m 375 m	Daily	Direct Broadcast (CIMSS) NOAA CLASS
Landsat 7 Landsat 8	ETM+ OLI	Natural Color NDVI	30 m	16 Days	USGS Earth Explorer
Commercial	Varies	Panchromatic True Color	< 1 m 1 m	On Demand	USGS Hazards Data Distribution System
International Charter	Varies	Panchromatic True Color / NDVI	1-10m	Varies	USGS Hazards Data Distribution System
Sentinel 1A/B	SAR	RGBs, Backscatter	5 m	12 Days	Alaska Satellite Facility
Sentinel 2A	MSI	NDVI True / False Color	10-20 m	12 Days	USGS Earth Explorer / HDDS ESA

Latency of products varies, typically higher spatial resolution results in decreased frequency or greater latency, but analysts can use information up to 60 days post-event.

Imagery Resolution

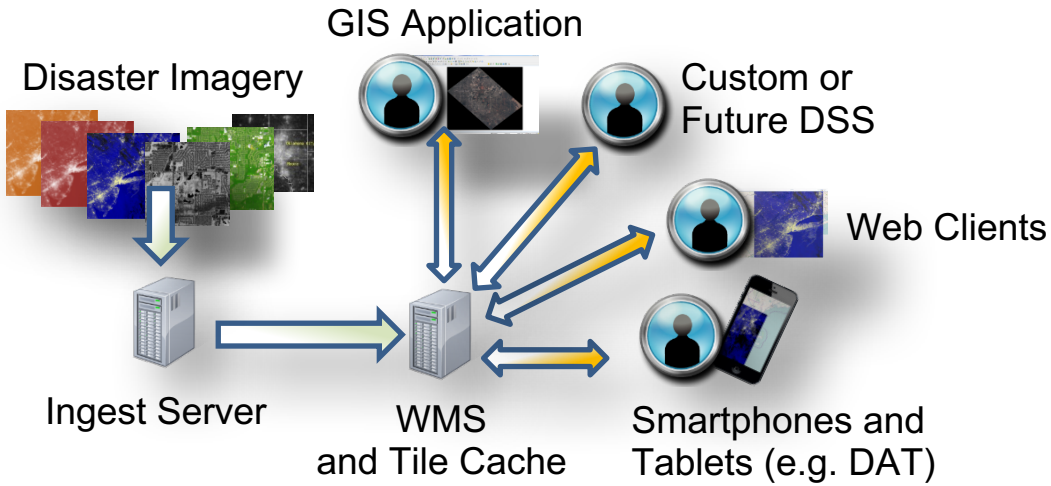


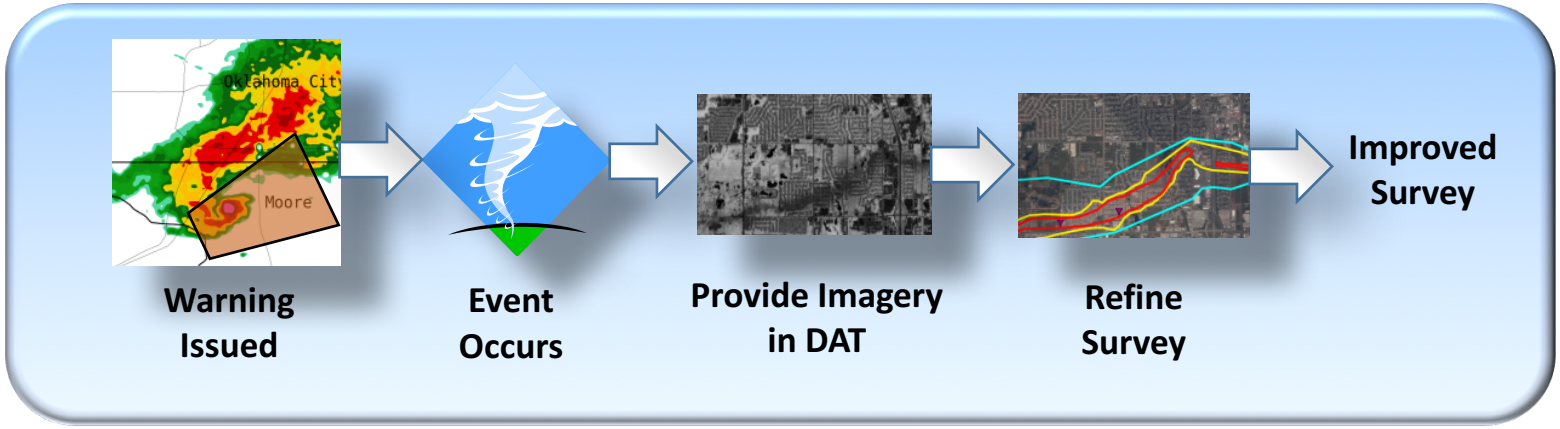
Affects Detectability of Damage Indicators

Increases in Spatial Resolution Improves Detection Capabilities

Reference: Molthan, A. L., J. R. Bell, T. A. Cole, and J. E. Burks, 2014: Satellite-based identification of tornado damage tracks from the 27 April 2011 severe weather outbreak. J. Operational Meteor., 2 (16), 191–208.

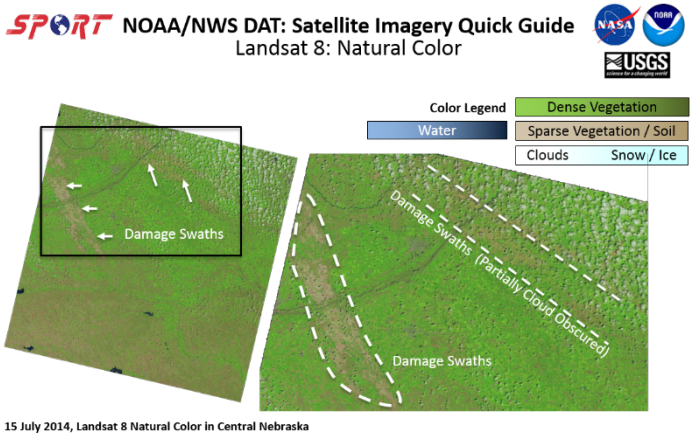
Data Dissemination and Use Case





Imagery Support and Training

- SPoRT provides training and support for delivered products.
- The team provided teletraining to partnering WFOs in NWS Southern Region
- A series of “Quick Guides” has been established for “just in time” training and use of data during operations.



15 July 2014, Landsat 8 Natural Color in Central Nebraska

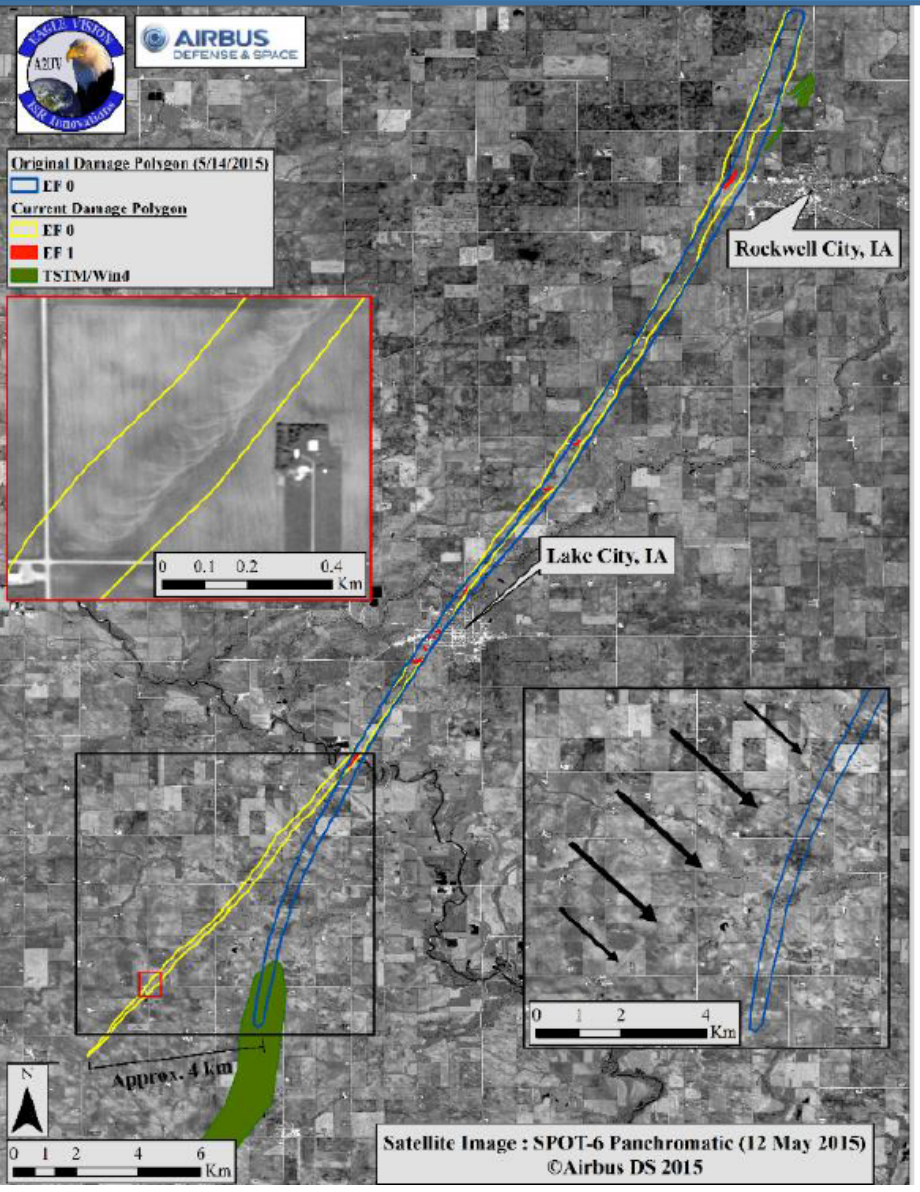
Access	SPoRT > Landsat 8 > Natural Color
Restrictions	None
Resolution	30 m
Latency	Landsat 8 has a 16 day repeat cycle. It observes the same location every 16 days.
Provider	USGS / NASA SPoRT
Spectral Bands	Three red and near-infrared bands (6,5,4) are combined to create an image similar to true color, but with additional discrimination of clouds and snow.
Application	Damage tracks are typically identified as brown scars against a green, vegetated background. Corroborate suspected damage tracks with other information.

How is the image generated?
- Reflectance in the red and near-infrared bands (6,5,4) is combined into a single false-color image to approximate a true color appearance.

What should I be looking for in this product?
- Red and near-infrared bands are often used to measure vegetation health. Tracks are apparent as linear features along the storm path, typically in shades of brown where vegetation and soils have been disrupted.
- Suspected track location can be corroborated with radar rotational track information or survey information.

What are the product limitations?
- Limited swath width may truncate portions of the track that continue outside of the scene.
- Clouds and cloud shadows may obscure portions of the damage track.

10 May 2015: Lake City/Rockwell City EF-1

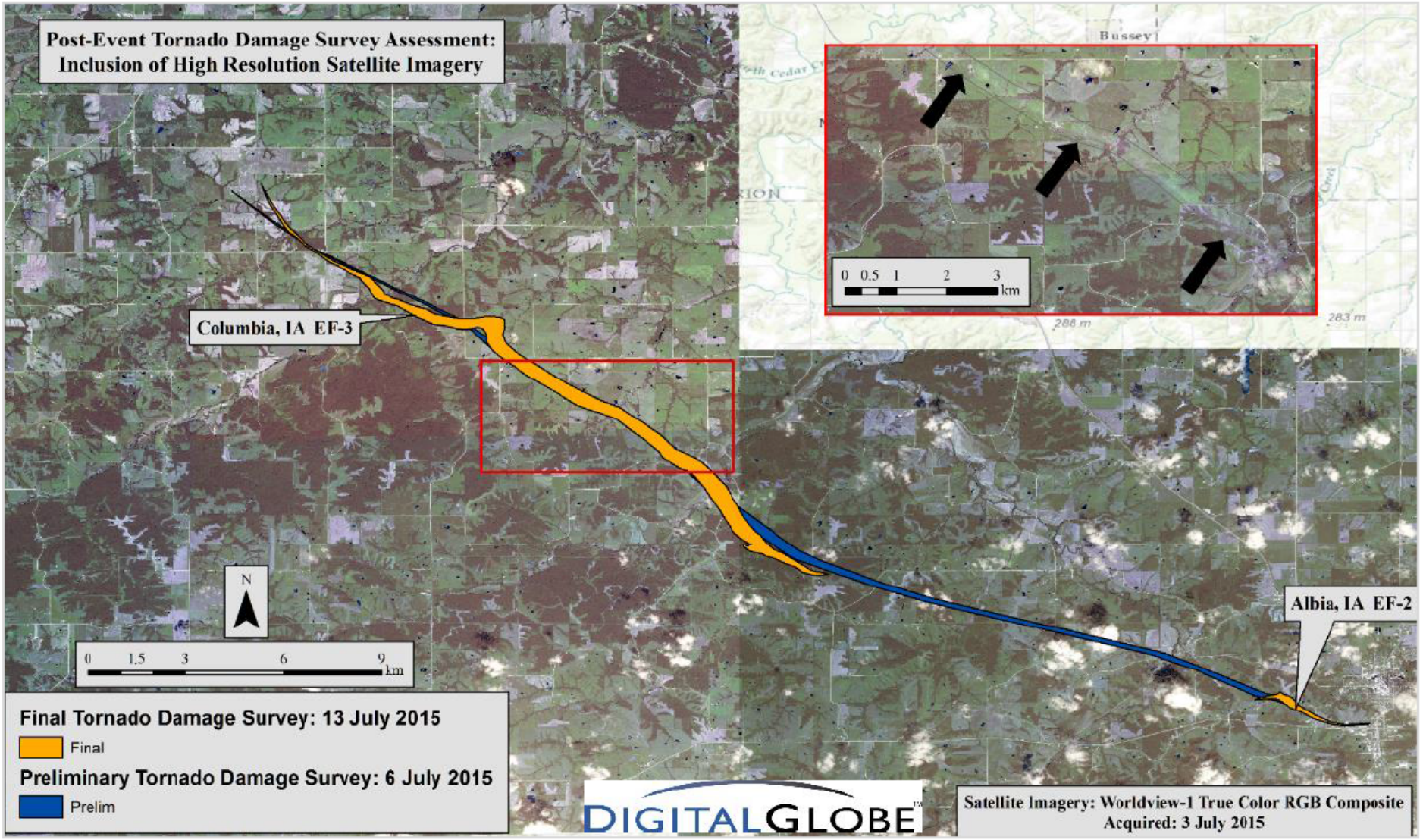


CMT request on the 10th of May 2015

SPOT-6 Panchromatic from 12 May 15

Landsat 8 pass available on 17 May 2015, but was too cloudy to use.

22 June 2015: Columbia, Albia Eddyville, IA



Challenges

- Sensors available with minimum latency provide coarser resolution imagery, while higher resolution imagery is often needed for mapping tornado tracks.
  - Majority of tornadoes EF0-2, typically shorter and thinner in track, not producing signals observed at coarser spatial resolution (250-375m).
- Large variety in data formats, geolocation quality, processing needs, and data distribution methods for higher resolution platforms.
  - Integration often requires value-added processing and hosting in a manner ingestible by the NOAA/NWS DAT.

Challenges

- Many end-users unfamiliar with the broad range of remote sensing available beyond geostationary, including NOAA/NASA polar orbiters, SAR, commercial, and International Charter platform
- Some Charter and commercial products require further polish to go from digital count to reflectance, ideally including atmospheric correction, then to false color or other change detection products.
  - Some commercial and other products can vary in their geolocation quality, pre-processing, etc.
- Automated techniques to extract anomalies/features can be helpful, but surveyors still need to incorporate other ground truth information to sketch the final track and add information about varying intensity

Lessons Learned

- Latency and product regularity issues can be resolved through end-user partnerships, managing expectations, and providing appropriate training
- Users are best served by having a common GIS infrastructure that can be seamlessly incorporated within their end-user, decision-making software
  - Here, WMS for raster distribution along with a JSON interface to communicate with the DAT.
- Ongoing and fugure efforts with data providers should explore creating value-added products at the source, to improve consistency and downstream value to other users served by the original provider.
  - Address issues upstream to benefit more users downstream

Future Work / Transition Plan

- Winter 2016
  - TBD
- Spring 2017
  - TBD
- Summer 2017
  - TBD

Questions?

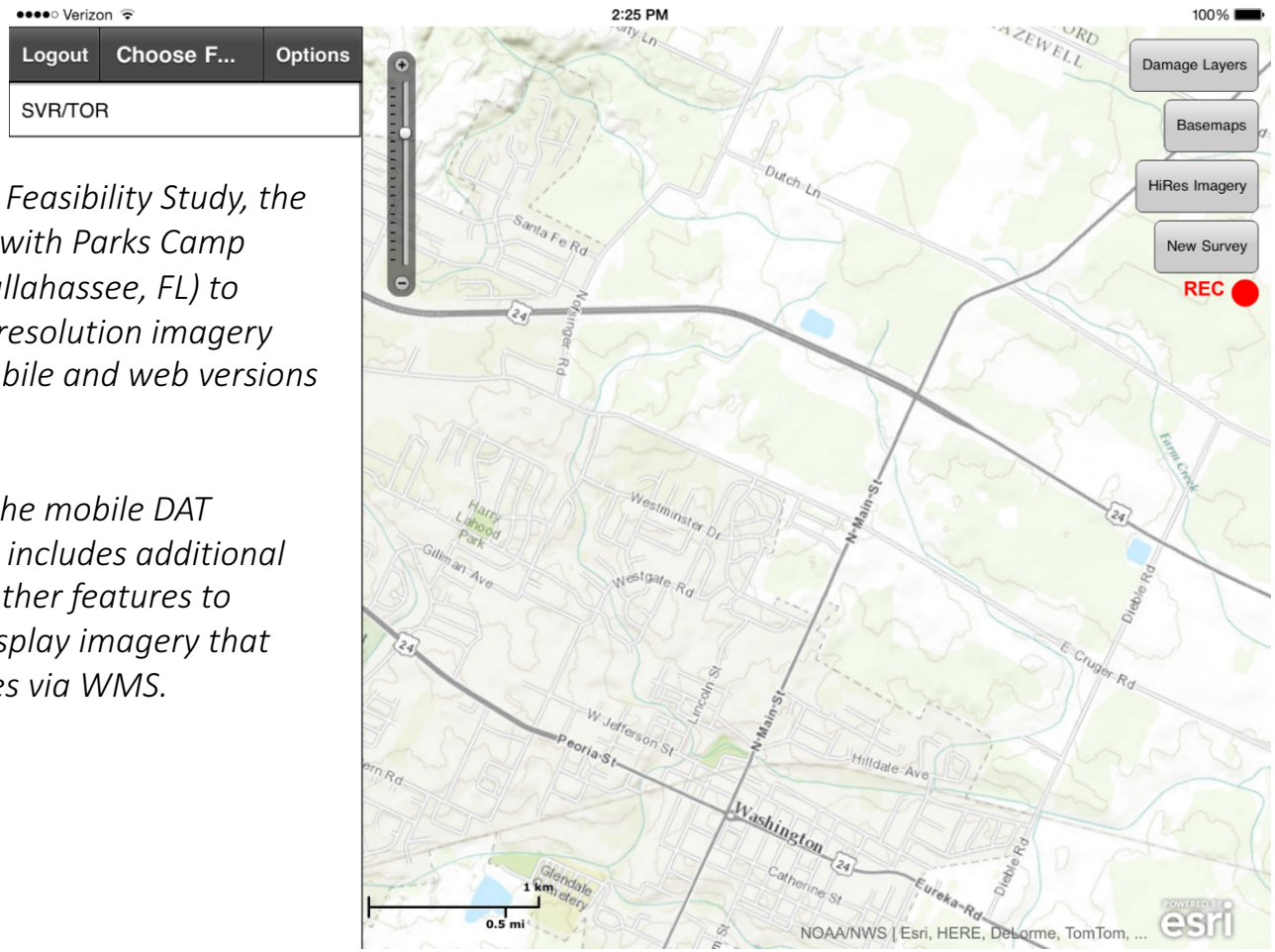
- If you're interested in learning more about the project, or collaborating on value-added products to help with severe weather response, contact our team at andrew.molthan@nasa.gov

Backups

Damage Assessment Toolkit

As part of the Feasibility Study, the team worked with Parks Camp (NWS WFO Tallahassee, FL) to integrate full resolution imagery within the mobile and web versions of the DAT.

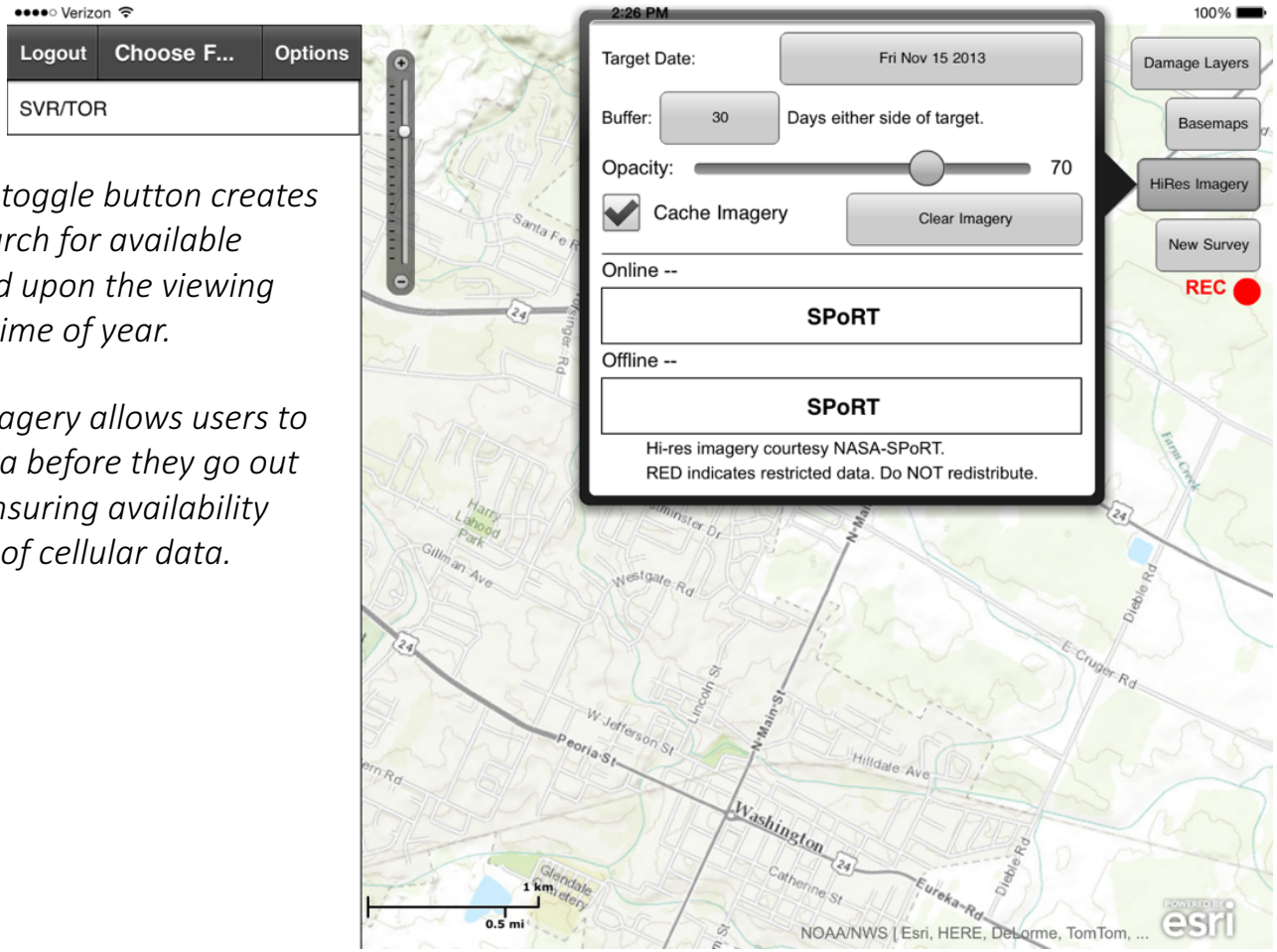
Shown here, the mobile DAT interface now includes additional buttons and other features to search and display imagery that SPoRT provides via WMS.



Damage Assessment Toolkit

An additional toggle button creates a menu to search for available imagery based upon the viewing location and time of year.

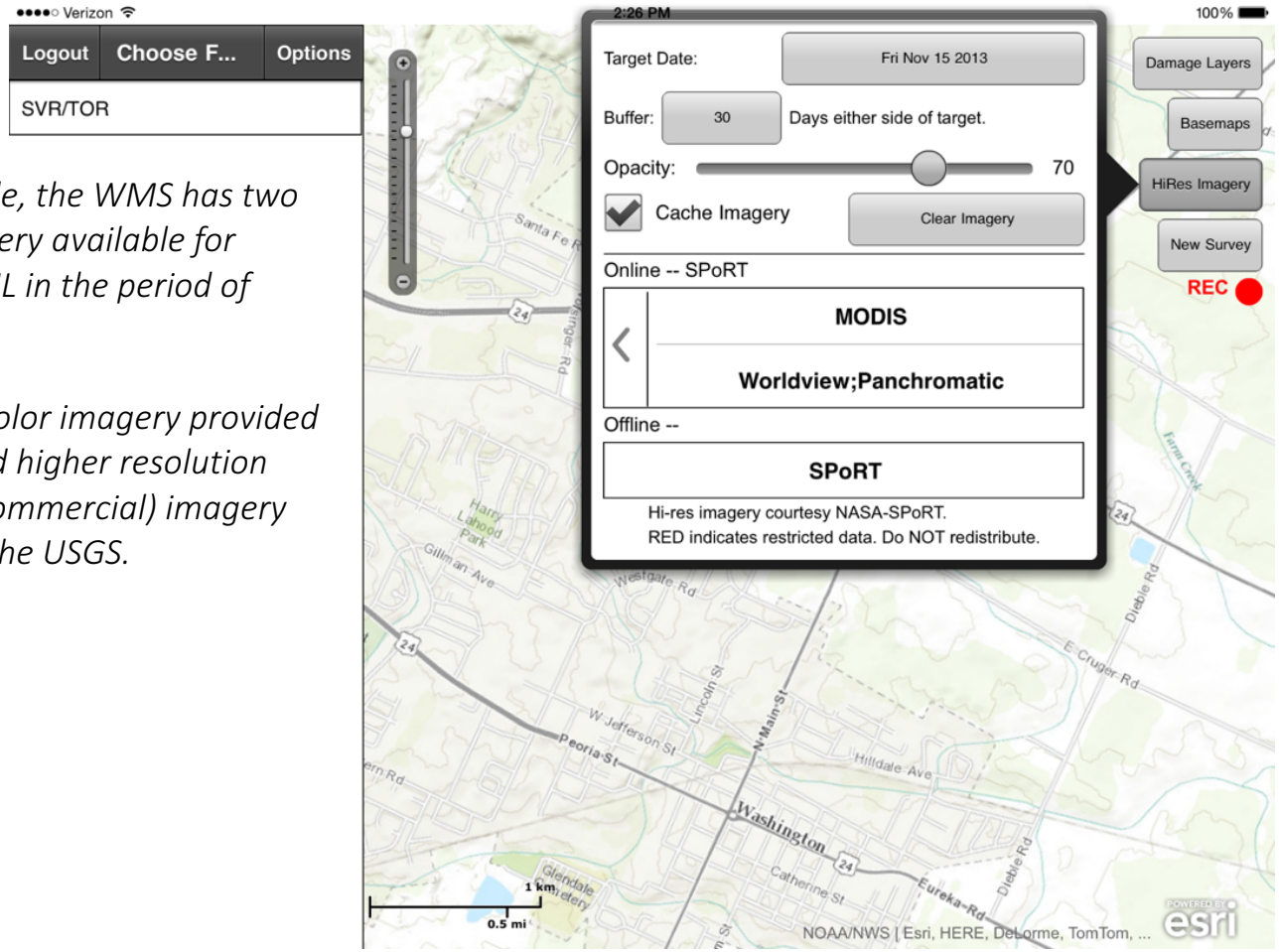
Caching of imagery allows users to download data before they go out to the field, ensuring availability despite a loss of cellular data.



Damage Assessment Toolkit

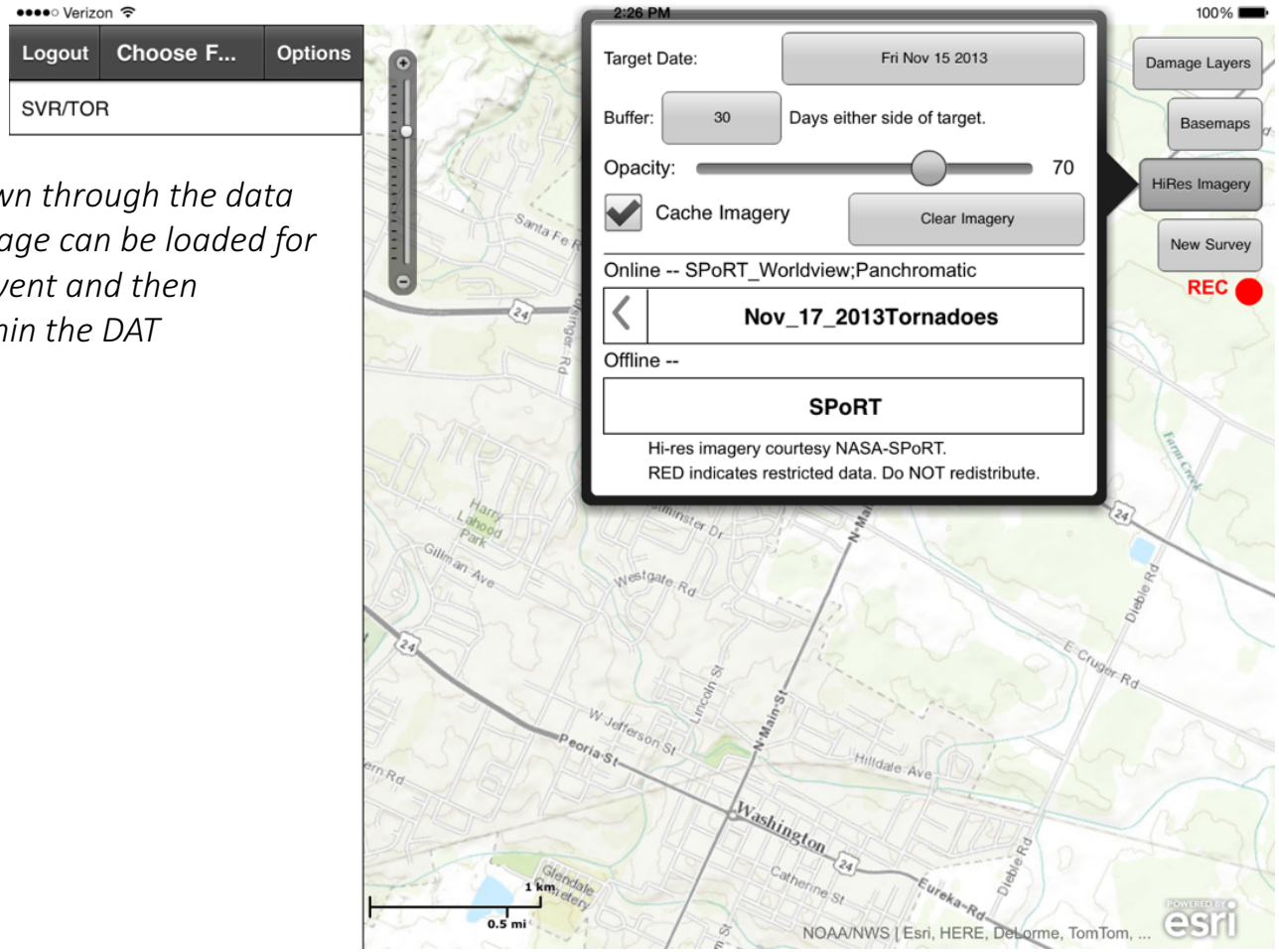
In this example, the WMS has two types of imagery available for Washington, IL in the period of interest:

MODIS true color imagery provided via SPoRT, and higher resolution Worldview (commercial) imagery provided via the USGS.

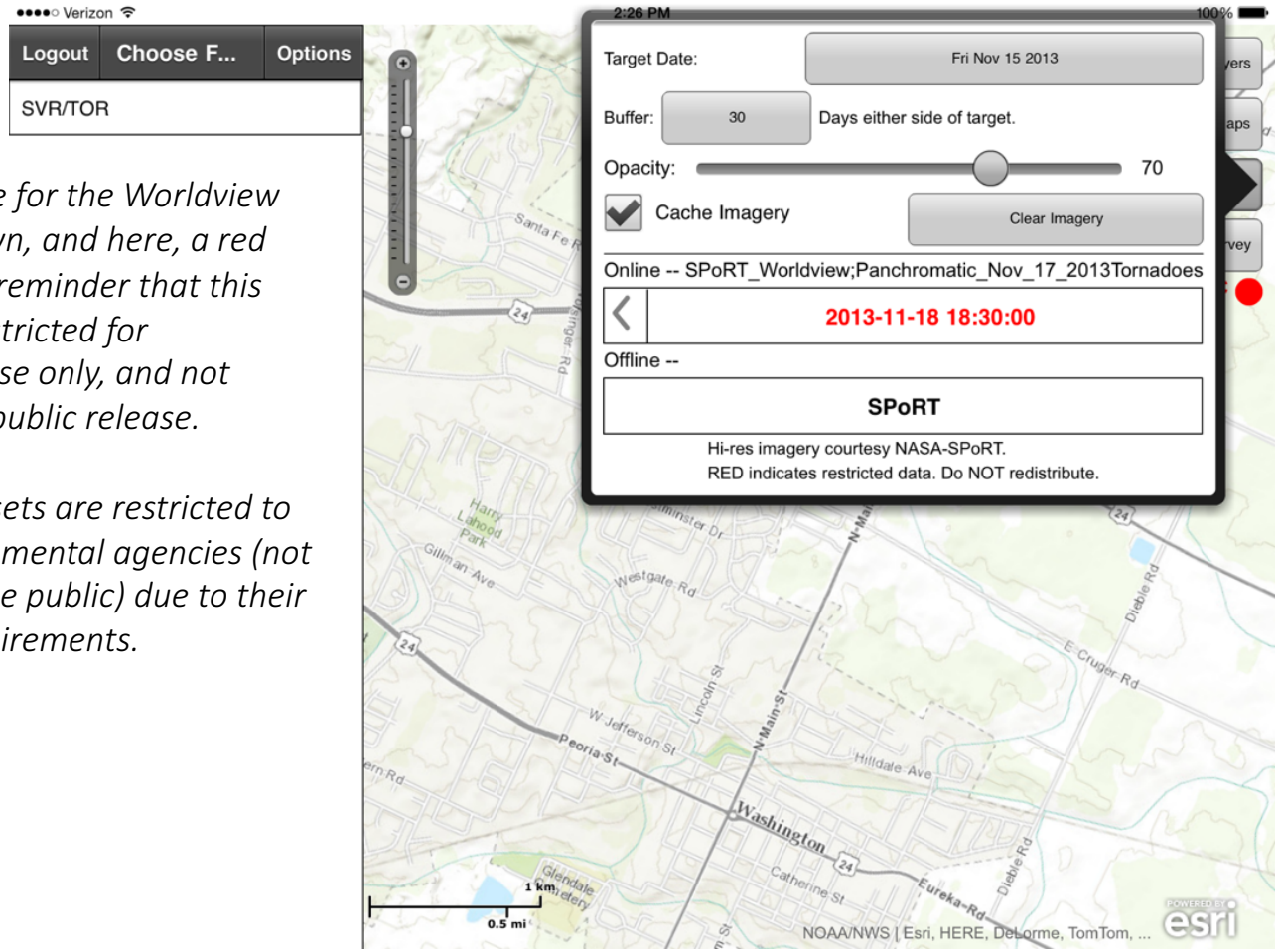


Damage Assessment Toolkit

By drilling down through the data menus, an image can be loaded for this specific event and then displayed within the DAT application.



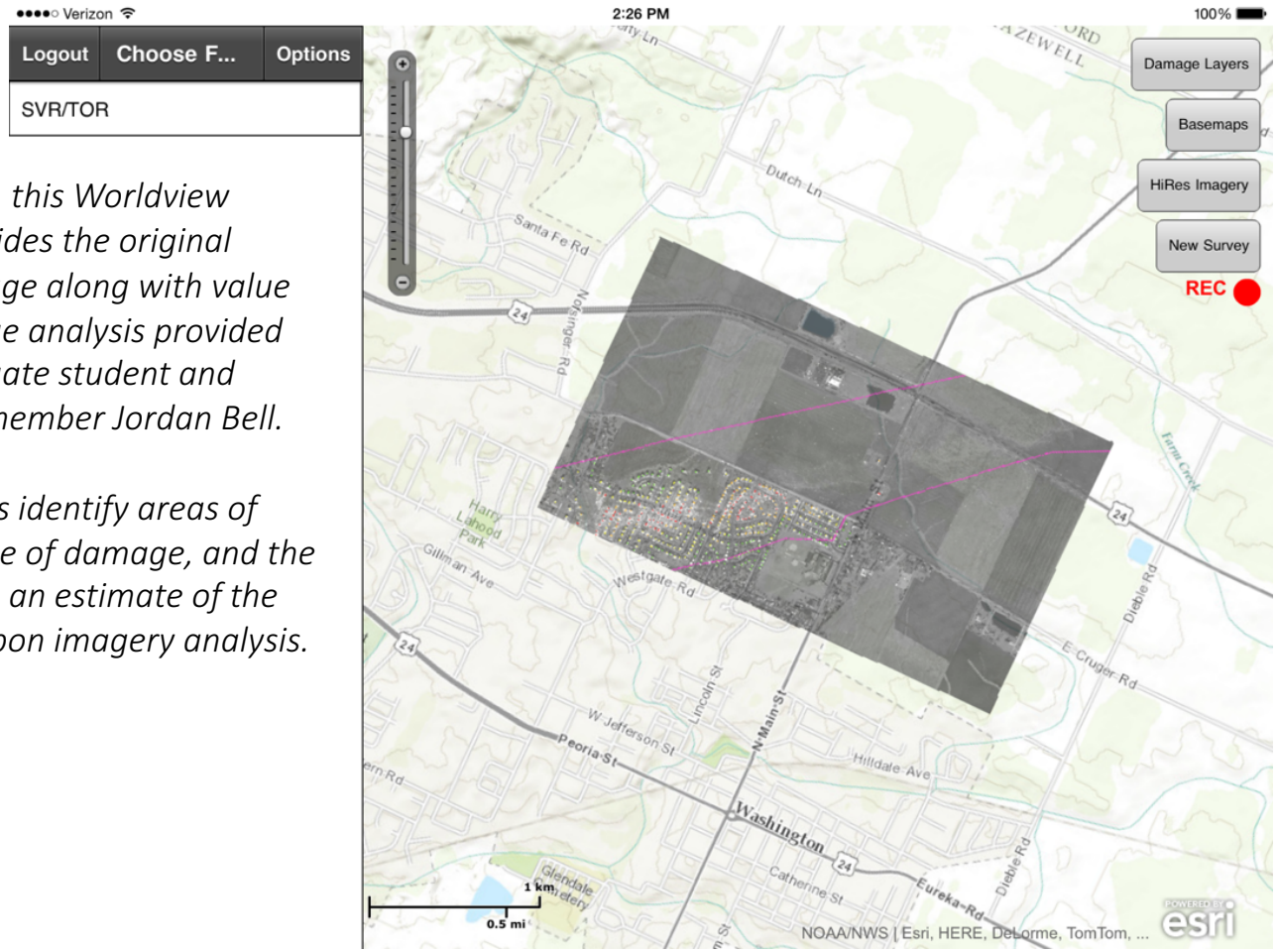
Damage Assessment Toolkit



Date and time for the Worldview image is shown, and here, a red text view is a reminder that this imagery is restricted for NOAA/NWS use only, and not available for public release.

Certain data sets are restricted to use by governmental agencies (not released to the public) due to their licensing requirements.

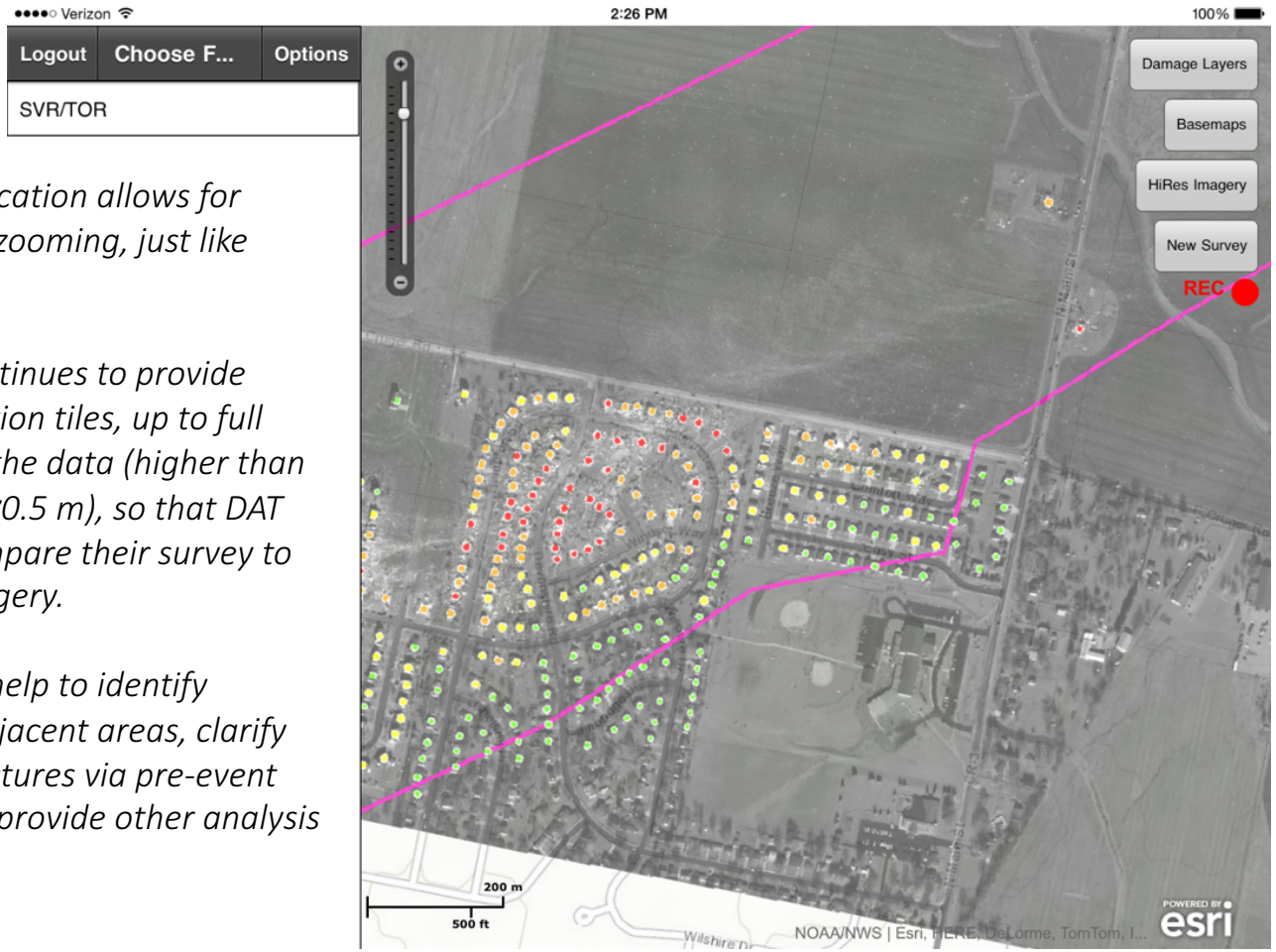
Damage Assessment Toolkit



When loaded, this Worldview example provides the original grayscale image along with value added damage analysis provided by UAH graduate student and SPoRT team member Jordan Bell.

Colored points identify areas of varying degree of damage, and the pink outline is an estimate of the path based upon imagery analysis.

Damage Assessment Toolkit



The DAT application allows for pinching and zooming, just like Google Maps.

The WMS continues to provide higher resolution tiles, up to full resolution of the data (higher than shown here, ~0.5 m), so that DAT users can compare their survey to available imagery.

Imagery can help to identify damage in adjacent areas, clarify previous structures via pre-event imagery, and provide other analysis capabilities.

Damage Assessment Toolkit